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Abstract

RELEASE AND TRANSPORT OF FISSION PRODUCTS UNDER REACTOR ACCIDENT CONDITIONS

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Data on the release, transport, and removal of fission products released from various fuels under simulated accident conditions are being obtained at over a dozen difference laboratories in the U. S. as a consequence of the general studies sponsored by the USAEC's Reactor Safety Program as well as the more specific investigations undertaken by various reactor programs.

To date most of the work on fission-product release has been directed toward metallic uranium, uranium alloy, and UO_2 fuel materials although limited data are also available on releases from UC and BeO/UO_2 fuels. Data are presented for all fuels as a function of a number of parameters which generally include temperature (up to melting), time (several hours), burnup (up to 11 000 MWd/ton), and ambient atmosphere (steam, air, He, CO_2). Most of the data were obtained out-of-pile using induction; resistance; or plasma-heating techniques although some in-pile results are included.

In general, quantitative releases of the noble gases and iodine may be expected when UO_2 is melted, frequently with significant (up to 100%) release of Cs and Te. Comparable releases are obtained at somewhat lower temperatures ~2000F (1090C) but require several hours. On the other hand, Sr released from UO_2 was $\ll$ 1% except at high temperatures >2900F (1600C) in helium. In both the oxide and the metal, burnup accelerated the rate of release. However, the influence of burnup on the fractional releases of fission products from the metal is considered minor when compared to the other variables. With uranium metal, fractional releases similar to those

from UO_2 are obtained. In addition to release measurements, characterization of the released activity (in terms of its physical and chemical form), its transport (principally deposition), and its removal from air constitute the other principal areas of experimental work. However, the many deposition results reported lend themselves only to a few qualitative generalizations - for example, the nonvolatiles plateout close to the point of release at temperatures above 1830F (1000C).

The characterization studies have emphasized iodine behavior because of its relative hazard potential and have produced interesting, if not completely definitive, results. In helium at 2200F (1200C) iodine is released from the irradiated metal in combined form, which is partly dissociated at higher temperatures and appears as elemental iodine when subsequently oxidized. Particles identified to date ranged from 0.004-μm iodine vapor particles to 250-μm particles resulting from oxidation of uranium in air, these sizes representing the extremes of some not-too-well-defined distributions. In any event, large concentrations of small particle size will soon agglomerate so that the physical characterization is a strongly time-dependent exercise.

Fission-product-removal studies, including sprays, scrubbers, scavenging, and filtration, have been quite extensive and have been quite definitive as far as filters are concerned. Reliable performance of charcoal adsorbers for iodine and particulate filters has been consistently demonstrated with removal efficiencies in excess of 99% even in a steam atmosphere.

By and large, the present investigations are continuing and are being supplemented with larger-scale experiments, for example, the Nuclear Safety Pilot Plant (NSPP), Loss of Flow Test (LOFT), and the Containment Systems Experiment (CSE) which are intended to demonstrate the validity and/or limitation of the extrapolations of the laboratory data as applied to the evaluation of the activity behavior in reactor accidents.